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- G. N. Collins, Bureau of Plant Industry, Washington, D. C.
 J. A. Detlefsen, assistant professor of genetics, University of Illinois.
 R. A. Emerson, professor of plant breeding, Cornell University.
 H. D. Goodale, biologist, department of poultry husbandry, Massachusetts Agricultural College.
 John W. Gowen, biologist, Maine Agricultural Experiment Station.
 H. K. Hayes, professor of plant breeding, University of Minnesota.
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 Edward N. Wentworth, Armour's Bureau of Agricultural Research and Economics, Union Stock Yards, Chicago.
 Sewall Wright, senior animal husbandman, Bureau of Animal Industry, Washington, D. C.

DOCTORATES CONFERRED IN THE SCIENCES BY AMERICAN UNIVERSITIES IN 1920. II

ENGINEERING

- COLUMBIA: Mortimer Thomas Harvey, "Bakelite intermediates." Frank Abraham Struss, "Benzoic acid from benzene."
 GEORGE WASHINGTON: Alanson David Morehouse, "Rainfall and run-off and the hydraulics of drainage ditches."
 JOHNS HOPKINS: Frederick William Lee, "Electric strength of air under continuous potentials and as influenced by temperature."
 WISCONSIN: Harold Marion Crothers, "Selective properties of coupled radio circuits."

GEOGRAPHY

- HARVARD: Roderick Peattie, "Geographic conditions of the lower St. Lawrence Valley."
 WISCONSIN: Leonard Bayliss Krueger, Title of thesis not given. Selma Langenhan Schubring, "A statistical study of lead and zinc mining in Wisconsin."

Geology

- CALIFORNIA: Nicholas Lloyd Taliaferro, "Manganese deposits of the Sierra Nevada of California." Frank Samuel Hudson, "Geology of the Cuyamaca region, California, with special reference to the origin of the nickeliferous pyrrhotite."

CHICAGO: Paul MacClintock, "Pleistocene history of the lower Wisconsin Valley." Bertram Reid MacKay, "Geology and physiography of the Beauceville map area, Quebec, with special reference to placer gold deposits." Horace Noble Coryell, "Bryozoon fauna of the Stones River formation of central Tennessee." Ralph Works Chaney, "Flora of the Eagle Creek Formation."

ILLINOIS: Clarence Samuel Ross, "Differentiation and contact metamorphism of the Snowbank syenite in the Vermillion iron bearing region of Minnesota." Luther Eugene Kennedy, "Cacahuabie granite and porphyry and their contact effects."

MASSACHUSETTS: George Hanson, "Some Canadian occurrences of pyritic deposits in metamorphic rocks."

MINNESOTA: Arthur Jerrold Teije, "Cambrian sedimentation in the Big Horn Mountains."

PRINCETON: Benjamin Franklin Howell, "Cambrian paradoxides beds at Manuels, Newfoundland."

YALE: William Sidney McCann, "Geology and mineral deposits of the Bridge River map-area, British Columbia." Chester Ray Longwell, "Geology of the Muddy Mountains, Nev., with a section to the Grand Wash Cliffs in Arizona." George Sherwood Hume, "Stratigraphy and geologic relations of the Paleozoic outlier of Lake Timiskaming, Ontario." Kirk Bryan, "Geology, physiography, and water resources of the Papago Country, Arizona." Walter Andrew Bell, "Stratigraphy of the Horton-Windsor District, Nova Scotia."

MATHEMATICS

- BRYN MAWR: Bird Margaret Turner, "Plane cubics with a given quadrangle of inflexion."
 CALIFORNIA: Elsie Jeanette McFarland, "On a special quartic curve."
 CHICAGO: Cyril Arthur Nelson, "Conjugate systems with conjugate axis curves." Gladys Elizabeth Carson Gibbens, "Comparison of different line-geometric representations for functions of a complex variable." John Wayne Lasley, Jr., "Some special cases of the flecnodal transformation of ruled surfaces." William Lloyd Garrison Williams, "Fundamental systems of formal modular seminvariants of the binary cubic."
 COLUMBIA: Emil L. Post, "Introduction to a general theory of elementary propositions."
 CORNELL: George Merritt Robinson, "Divergent double sequences and series."

HARVARD: Hyman Joseph Ettlinger, I. "Existence theorems for the general real self-adjoint linear system of the second order. II. Oscillation theorems for the real self-adjoint linear system of the second order." Joseph Leonard Walsh, "On the location of the roots of the Jacobian of two binary forms."

ILLINOIS: Roseoe Woods, "Elliptic modular functions associated with the elliptic norm curve E." Charles Francis Green, "On the summability and regions of summability of a general class of series of the form $\sum (x+n)$." Leonard Leo Steimley, "On a general class of series of the form $\sum (n-x)$."

MICHIGAN: John David Bond, "Plane trigonometry in Richard Wallingford's quadripartitum de sinibus demonstratis." Susan Miller Rambo, "Point of infinity as a regular point of certain linear difference equations of the second order."

PRINCETON: Edward Sanford Hammond, "Periodic conjugate nets of curves." Henry Roy Brahmans, "Curves on surfaces."

SYRACUSE: Tsao-Shing Yang, "Moving trihedral associated with a triply orthogonal system of surfaces—theory and application." Jason John Nassau, "Some theorems in alternants."

WISCONSIN: Thornton Carle Fry, "Use of divergent integrals in the solution of differential equations."

Pathology

CALIFORNIA: Hilda Hempl Heller, "Etiology of acute gangrenous infections of animals: a discussion of blackleg, brazy, malignant oedema, and whale septicæmia."

MINNESOTA: Carl Arthur Hedblom, "Treatment of chronic empyema." Georgine Luden, "Influence of cholesterol metabolism and other factors in carcinoma."

Physics

CALIFORNIA: Charles Henry Kunsman, "Study of the residual ionization in gases with reference to temperature effects."

CHICAGO: John Bewley Derieux, I. "Use of mercury droplets in Millikan's experiment. II. Photoelectric effects on mercury droplets." Ralph Alanson Sawyer, "Metallic spark spectra in the extreme ultra violet." Mervin Joe Kelly, "Valency of photo-electrons and the photo-electric properties of some insulators." Harold Horton Sheldon, "Charcoal activation." Oswald Hance Blackwood, "On the existence of homogeneous groups of large ions." Ira Gar-

nett Barber, "Secondary electron emission from copper surfaces." Otto Koppius, "Comparison of thermionic and the photoelectric work-functions in platinum."

CINCINNATI: Harold Frederick Richards, "Electrification by impact."

CORNELL: Austin Bailey, "Study of the effect of adsorbed gas on the high frequency resistance of copper wire."

HARVARD: Yu Ching Wen, "Theoretical treatment of the radiation resistance of antennæ excited by damped and undamped waves at all ranges of wave-lengths." Elmer Raymond Schaeffer, "Atmospheric attenuation of ultra-violet light." David Arnold Keys, "On a piezo-electric method of measuring explosion pressures."

ILLINOIS: William Henry Hyslop, "A method of determining dielectric constants of liquids by undamped oscillations."

IOWA STATE: George Ray Wait, "Hall effect and the specific resistance of thin silver films." Paul Streep Helmick, "The blackening of a photographic plate as a function of the intensity of light and time of exposure."

MISSOURI: Francis Marion Walters, Jr., "Wave-length measurements in arc spectra photographed in the yellow, red and infra-red."

OHIO STATE: Enoch Franklin George, "Absorption of light by solutions of inorganic salts."

PENNSYLVANIA: George Rosengarten, "Effect of temperature upon the transmission of infra-red radiation through various glasses." John Clarence Karcher, "Wave-length measurements in the M series of some high frequency spectra."

Physiology

CALIFORNIA: John Augustus Larson, "Further evidence on the functional correlation of the hypophysis and thyroid."

CHICAGO: Thomas Leon Patterson, "Studies on gastric hunger contractions in amphidia and reptilia." Lester Reynold Dragstedt, "Studies in acute intestinal obstruction." Bernard Raymond, "Alkali reserve in experimental surgical shock." Emma Anna Kohman, "Experimental production and control of hunger edema."

CLARK: Charles Bird, "Genetic study of hunger."

COLUMBIA: Anna Baker Gates, "The mechanism of the recovery or maintenance of systemic blood pressure after complete transection of the spinal cord."

HARVARD: McKeen Cattell, "Some effects of ether and morphine on the blood and circulation in

- shock." Edward Frederick Adolph, "Quantitative study of the interrelations of oxygen and carbon dioxide with hemoglobin in blood."
- ILLINOIS: Alma Jessie Neill, "Comparison of the rate of diffusion of certain substances."
- INDIANA: Paul Montgomery Harmon, "Influence of temperature and other factors upon the two-submitted contraction curve of the *gastronemius* muscle of the frog."
- JOHNS HOPKINS: Helene Connet, "Effect of adrenalin on the venous blood pressure."
- LELAND STANFORD: Rollin Guizot Myers, "Studies on the blood of marine animals."
- YALE: George Eric Simpson, "Effect of diet on the excretion of indican and the phenols."
- Psychology*
- CATHOLIC: Othmar Solnitsky, "Factors in economic learning."
- CHICAGO: Joseph Ussery Yarbrough, "Influence of time interval upon the rate of learning in the white rat." Chih Wei Luh, "The conditions of retention." Edward Stevens Robinson, "Some factors determining the degree of retroactive inhibition." Guy Thomas Buswell, "Experimental study of the eye-voice span in reading." Forrest Alva Kingsbury, "A group intelligence scale for primary grades." Margaret Wooster, "Certain factors in the formation of a new spatial coordination."
- CLARK: Francis Cecil Sumner, "Psychoanalysis of Freud and Adler."
- COLUMBIA: Dean R. Brimhall, "Family resemblances among American men of science." Evelyn Gough, "Effects of practise on judgments of absolute tone." Myra Elizabeth Hills, "Standardization of the analogies test." Georgina Ida Strickland, "Individual differences as affected by practise."
- CORNELL: Hubert Sheppard, "Foveal adaptation to color." Louis Benjamin Hoisington, "On the non-visual perception of the length of lifted rods." Cheves West Perky, "An experimental study of the imagination." Michael Jacob Zigler, "An experimental study of visual form." Homer Guy Bishop, "An experimental investigation of the positive after-image in audition." Claire Comstock, "An experimental study of meaning and imagery." Forrest Lee Dimmick, "Visual movement and the phi phenomenon." Robert Thomas Holland, "The after-image of pressure." Alice Helen Sullivan, "An experimental study of kinæsthetic imagery."
- GEORGE WASHINGTON: Dudley Ward Fay, "A psycho-analytic study of some psychoses associated with frank endocrine disorders."
- HARVARD: Charles Arthur Coburn, "Heredity of wildness and savageness in mice." George Humphrey, "Conditioned reflex in education." Yueh Tang, "Affective factors in perception." Charles Hart Westbrook, "Measurement of ability in reading." Zenas Clark Dickinson, "Study of the psychological theory of action with reference to economic theory."
- ILLINOIS: Coleman Roberts Griffith, "Organic and mental effects of repeated bodily rotation."
- INDIANA: Hazel Irene Hansford, "Mental and social survey of a degenerate family." Luella Winifred Pressey, "Measurement of intelligence and school attainment in the first three school grades."
- IOWA STATE: Clarence Frederick Hansen, "Serial action as the basic measure of motor capacity."
- JOHNS HOPKINS: David June Carver, "Immediate psychological effects of tobacco smoking." Wilbur Harrington Norcross, "Experiments on the transfer of training."
- LELAND STANFORD: William Thomas Root, Jr., "Socio-psychological study of 53 supernormal children." James Leroy Stockton, "Definition of intelligence in relation to modern methods of mental measurement." Arthur Sinton Otis, "Absolute point scale for the group measurement of intelligence."
- MICHIGAN: Sarah Davina MacKay Austin, "Study in logical memory."
- OHIO STATE: Jeanette Chase Reamer, "Mental and educational measurement of the deaf by the group method."
- PRINCETON: Edgar Arnold Doll, "Growth of intelligence."
- YALE: Arthur Dart Bissell, "Rôle of expectation in music."
- Zoology*
- CALIFORNIA: Henry Homer Collins, "Studies of the pelage phases and of the nature of color variations in mice of the genus *Peromyscus*."
- CHICAGO: Benjamin Harrison Willier, "Structures and homologies of free-martin gonads."
- COLUMBIA: Clara Julia Lynch, "Unisexual sterility in *Drosophila*." Shellby R. Safr, "Genetic and cytological examination of primary non-disjunction in *Drosophila melanogaster*." Franz Schrader, "Sex determination in the white fly." Mary Bertha Stark, "Hereditary tumor in the fruit fly, *Drosophila*."

- CORNELL: Walter Norton Hess, "Studies on the Lampyridæ." Clarence Hamilton Kennedy, "Study of the phylogeny of the Zygoptera." Fred Waldorf Steward, "Development of the cranial sympathetic ganglia in the rat." Benjamin Percy Young, "Attachment of the abdomen to the thorax among Diptera." Laura Florence, "Hog louse, *Hæmatopinus suis*, Linné: its biology, anatomy and histology." Walter Housley Wellhouse, "Insect fauna of the genus *Cratægus*."
- GEORGE WASHINGTON: Benjamin Schwartz, "Hemotoxins from parasitic forms." Frank Alexander Wetmore, "Body temperature of birds." Thomas Elliott Snyder, "Colonizing termites."
- HARVARD: Vasil Obreshkove, "Photic reactions of tadpoles in relation to the Bunsen-Roscoe Law." James Montrose Duncan Olmsted, "Experiments on the olfactory and gustatory organs of *Amiurus nebulosus* (Lesueur)." Herbert Greenleaf Coar, "Shell of *Balanus eburnus*." William Norton Barrows, "Modifications and development of the arachnid palpal claw, with especial reference to spiders." Leslie Clarence Dunn, "Linked genes in mammals." Alfred Charles Kinsey, "Studies of gall-wasps (*Cynipidæ hymenoptera*)."
- ILLINOIS: Hachiro Yuasa, "Classification of the larvæ of Tenthredinoidea."
- INDIANA: William Marion Goldsmith, "Comparative study of the chromosomes of the tiger beetles (*Cicindelidæ*)." William Ray Allen, "Studies of the biology of freshwater mussels."
- IOWA STATE: Gertrude Van Wagenen, "Coral *Mussa fragilis*, and its development."
- JOHNS HOPKINS: Bessie Noyes, "Experimental studies on the life history of a rotifer reproducing parthenogenetically (*Proales decipiens*)."
- Hoyt Stilson Hopkins, "Conditions for conjugation in diverse races of *Paramecium*."
- KANSAS: Paul Bowen Lawson, "Cicadillidæ of Kansas."
- MICHIGAN: Walter Norman Koelz, "Coregonine fishes of Lake Huron."
- MISSOURI: Erwin Ellis Nelson, "Chemical composition of the ovaries and skeletal muscle of the fresh water gar, *Lepidosteus*."
- PENNSYLVANIA: Joseph Hall Bodine, "Factors influencing the water content and the rate of metabolism of certain Orthoptera."
- PRINCETON: Wilbur Willis Swingle, "Germ-cell cycle of *Anurans*. I. The male sexual cycle of *Rana catesbeiana*." Elmer Lentz Shaffer, "Germ-cells of *Cicada septemdecim* (Homoptera)."
- WISCONSIN: Bert Cunningham, "Some studies in the natural history and early development of *Chrysemys cinerea*." George Holman Bishop, Title for thesis not given. Archie Evans Cole, Title for thesis not given.
- YALE: Harry Hayward Charlton, "Spermatogenesis of *Lepisma domestica*." Ruth B. Howland, "Experiments on the effect of removal of the pronephros of *Amblystoma punctatum*."
- CALLIE HULL,
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SPECIAL ARTICLES

A METHOD OF STUDYING THE ABSORPTION-TRANSPIRATION RATIO IN NUTRIENT MEDIA

SEVERAL writers have shown that the water content of plants varies with the hour of the day. This variation is of course due to differences in the rates of water entrance and exit. Wilting takes place when the ratio of the rate of entrance to the rate of exit is less than unity whether caused by excessive transpiration or by a decrease in root absorption. These two plant processes may easily be studied as a laboratory exercise in plant physiology by using water culture plants exposed to different environmental conditions or placed in solutions of different osmotic pressures. The following experiment will serve to illustrate the manner in which changes in the strength of solutions affect the ratio of absorption to transpiration. The method here described is practically the same as one used by the writer in a series of experiments reported by Livingston.¹

The roots of a tomato plant were passed through a hole in the rubber stopper of a large mouth bottle of about 600 c.c. capacity. A water-tight seal of chewing gum was made around the stem of the plant; a 2 c.c. pipette, graduated to 1/20 c.c. and a thermometer were inserted into the bottle through the stopper.

¹Livingston, B. E., "Incipient Drying and Temporary and Permanent Wilting of Plants, as Related to External and Internal Conditions," Johns Hopkins Univ. Cir., March, 1917, pp. 176-82.